CLAIMS

We claim:

1. A central pattern generator-based system for controlling at least one mechanical limb, comprising

at least one mechanical limb; and

a non-biological central pattern generator that generates commands for controlling the at least one mechanical limb wherein commands are a function of sensory feedback.

2. The central pattern generator-based system of claim 1, including a system for phase adjustment of the central pattern generator based on a sensory trigger in or derived from sensory feedback.

3. The central pattern generator-based system of claim 1, including:

a system for phase adjustment of the central pattern generator based on at least one sensory trigger in or derived from sensory feedback; and

a system for controlling firing frequency of motoneurons as a function of the sensory feedback or the sensory trigger.

4. The central pattern generator-based system of claim 1, further including at least one memory device.

5. The central pattern generator-based system of claim 4, wherein the memory device controls adaptation of output from the central pattern generator.

6. The central pattern generator-based system of claim 5, wherein the output includes integrate-and-fire neurons.

7. The central pattern generator-based system of claim 1, wherein the system is at least one chip.

8. The central pattern generator-based system of claim 7, including at least one chip containing electronic analogues of biological neurons, synapses and time-constraints.

9. The central pattern generator-based system of claim 7, including at least one chip that includes dynamic memories and phase modulators.

10. The central pattern generator-based system of claim 1, wherein the system is a non-linear oscillator including electronic analogues of biological neurons, synapses and time-constraints, dynamic memories and phase modulators.

11. The central pattern generator-based system of claim 7, wherein the system includes at least one chip in which components are integrated with hardwired or programmable circuits.

12. The central pattern generator-based system of claim 1, wherein the central pattern generator is a distributed system of at least two non-linear oscillators.

13. The central pattern generator-based system of claim 12, wherein the distributed system includes at least one neuron phasically coupled to a neuron or a sensory input.

14. The central pattern generator-based system of claim 12, wherein the distributed system includes at least two neurons phasically coupled to each other, to another neuron, or to a sensory input.

15. The central pattern generator-based system of claim 14, wherein phasic coupling is in-phase, 180 degrees out of phase, or any number of degrees out of phase.

16. The central pattern generator-based system of claim 14, wherein phasic coupling is based on rhythmic movement application.

17. The central pattern generator-based system of claim 14, including a phase control circuit.

18. The central pattern generator-based system of claim 14, including at least one integrate-and-fire spiking motoneuron driven by the phasically coupled neurons.

19. The central pattern generator-based system of claim 1, including at least one muscle.

20. The central pattern generator-based system of claim 1, wherein the system is a robot.

21. The central pattern generator-based system of claim 7, wherein the system includes a central pattern generator chip and at least one biological neuron.

22. The central pattern generator-based system of claim 21, including multiple chips.

23. The central pattern generator-based system of claim 1, including at least one sensor for collecting sensory feedback.

24. The central pattern generator system of claim 23, including a system for phase adjustment of the central pattern generator based on at least one sensory trigger in the received sensory feedback.

25. The central pattern generator-based system of Claim 1, wherein the sensory feedback is received from the at least one mechanical limb.

26. The central pattern generator-based system of Claim 1, wherein the sensory feedback is received from a sensing modality.

27. A central pattern generator-based system for controlling a biological system for rhythmic movement, comprising

an interface with a biological system that can provide sensory feedback from said biological system; and

a non-biological central pattern generator that generates commands for controlling the biological system wherein commands are a function of sensory feedback.

28. The central pattern generator-based system of claim 27, including a system for phase adjustment of the central pattern generator based on a sensory trigger in or derived from sensory feedback.

29. The central pattern generator-based system of claim 27, including:

a system for phase adjustment of the central pattern generator based on at least one sensory trigger in or derived from sensory feedback; and

a system for controlling firing frequency of motoneurons as a function of the sensory feedback or the sensory trigger.

30. The central pattern generator-based system of claim 27, further including at least one memory device.

31. The central pattern generator-based system of claim 30, wherein the memory device controls adaptation of output from the central pattern generator.

32. The central pattern generator-based system of claim 31, wherein the output includes integrate-and-fire neurons.

33. The central pattern generator-based system of claim 27, wherein the system is at least one chip.

34. The central pattern generator-based system of claim 33, including at least one chip containing electronic analogues of biological neurons, synapses and time-constraints.

35. The central pattern generator-based system of claim 33, including at least one chip that includes dynamic memories and phase modulators.

36. The central pattern generator-based system of claim 27, wherein the system is a non-linear oscillator including electronic analogues of biological neurons, synapses and time-constraints, dynamic memories and phase modulators.

37. The central pattern generator-based system of claim 33, wherein the system includes at least one chip in which components are integrated with hardwired or programmable circuits.

38. The central pattern generator-based system of claim 27, wherein the central pattern generator is a distributed system of at least two non-linear oscillators.

39. The central pattern generator-based system of claim 38, wherein the distributed system includes at least one neuron phasically coupled to a neuron or a sensory input.

40. The central pattern generator-based system of claim 38, wherein the distributed system includes at least two neurons phasically coupled to each other, to another neuron, or to a sensory input.

41. The central pattern generator-based system of claim 40, wherein phasic coupling is in-phase, 180 degrees out of phase, or any number of degrees out of phase.

42. The central pattern generator-based system of claim 40, wherein phasic coupling is based on rhythmic movement application.

43. The central pattern generator-based system of claim 40, including a phase control circuit.

44. The central pattern generator-based system of claim 40, including at least one integrate-and-fire spiking motoneuron driven by the phasically coupled neurons.

45. The central pattern generator-based system of claim 27, including at least one muscle.

46. The central pattern generator-based system of claim 33, wherein the system includes a central pattern generator chip and at least one biological neuron.

47. The central pattern generator-based system of claim 46, including multiple chips.

48. The central pattern generator-based system of claim 27, including at least one sensor for collecting sensory feedback.

49. The central pattern generator system of claim 48, including a system for phase adjustment of the central pattern generator based on at least one sensory trigger in the received sensory feedback.

50. The central pattern generator-based system of Claim 27, wherein the sensory feedback is received from the at least one biological limb.

51. The central pattern generator-based system of Claim 27, wherein the sensory feedback is received from a sensing modality.

52. A method for controlling a mechanical or biological system for rhythmic movement, comprising:

(A) measuring sensory feedback to obtain measured sensory feedback;

(B) processing the measured sensory feedback to obtain data for a

plurality of designated parameters; and

(C) via a central pattern generator-based system, applying a set of rules to the obtained data to generate at least one signal for commanding the limb or biological system for rhythmic movement, wherein the central pattern generator-based system comprises a circuit that mimics a biological central pattern generator.

53. The method of claim 52, including (D) via the central pattern generator-based system, applying the generated signal to command the limb or biological system for rhythmic movement.

54. The method of Claim 52, wherein the central pattern generator system comprises a circuit comprising at least two coupled non-linear oscillators.

55. A robotics system comprising:

(a) a central pattern generator-based system that mimics a biological central pattern generator; and

(b) at least one sensory device.

56. The robotics system of claim 55, wherein the central pattern generator-based system receives sensory input from the at least one sensory device.

57. An autonomous movement device for providing rhythmic control, wherein the autonomous device comprises:

a non-biological central pattern generator that generates rhythmic control commands wherein commands are a function of sensory feedback.

58. The autonomous movement device of claim 57, including at least one mechanical limb.

59. The autonomous device of claim 58 wherein the limb is a leg, arm, wing or appendage for swimming.

60. The movement device of claim 58 including at least two limbs.

61. The movement device of claim 57, wherein the device is a breathing controller.

62. The movement device of claim 57, wherein the device is a pacemaker.

63. The movement device of claim 57, wherein the device is a running device.

64. A non-biological central pattern generator comprising:

a memory device; and

a system for manipulating neural phasic relationships.

65. A method for modifying a continuous waveform provided by a non-

biological central pattern generator, comprising the steps of:

(A) provision of a continuous waveform by a non-biological central pattern generator;

(B) provision of sensory feedback to the non-biological central pattern generator;

(C) rule-application by the non-biological central pattern generator to the sensory feedback;

(D) based on the rule-application, determination by the non-biological central pattern generator to modify or maintain the continuous wave form.

66. The method of claim 65, wherein the non-biological central pattern generator modifies the wave form.

67. The method of claim 65, wherein the rule-application is the application of adaptive ring rules.